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Research and Development Technical Report

ECOM-4401

REMOTELY PILOTED VEHICLE (RPV) TV SEARCH AND ACQUISITION TESTS

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April 1976

ECOM

US ARMY ELECTRONICS COMMAND FORT MONMOUTH, NEW JERSEY 07703

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A target acquisition test program was conducted by ECOM/TRADOC at Ft Huachuca, Arizona, during the period 4 November through 11 December 1974. A mini-RPV (Melpar E-35) carrying an unstabilized day TV camera was employed to detect, recognize, and identify a variety of stationary tactical targets.

The target acquisition tests consisted of both a road search and an area search. This report includes a description of the test equipment and the test design as well as a presentation and discussion of the test results.

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INTRODUCTION

The US Army Electronics Command (ECOM) and the US Army Training and Doctrine Command (TRADOC) conducted a joint experiment at Fort Huachuca, AZ from 4 November 1974 to 11 December 1974 to investigate the capabilities and limitations of existing developmental mini-RPV (miniature Remotely Piloted Vehicle) systems. The experiment was planned to assess:

a. The E-35 mini-RPV equipment capability in detecting, recognizing, and identifying stationary targets.

b. Employment and operational characteristics of this mini-RPV system.

c. The area search capability of this RPV system.

The test results will assist the military user in preparing his formal requirements for RPV systems. ECOM was given responsibility for conducting this experiment by the AMC RPV Weapon System Manager.

EQUIPMENT DESCRIPTION

a. Aircraft.

The RPV used in this test program was developed by the Melpar Division of E-Systems Inc. (Figure 1). It weighs 40 pounds and has a cruise speed of 50 miles per hour with a maximum endurance of 5 hours. The vehicle, a twin-boom pusher with a wing span of 10 feet and overall length of 8 feet, is powered by a 2.0 cubic inch, spark-ignition Olsen & Rice engine. It employs an autopilot that maintains aircraft altitude, heading and angle of attack.

b. Sensor Payload.

The aircraft's payload was a Melpar-designed unstabilized television system which utilizes a low cost Javelin-type 8844 vidicon tube with approximately 500 lines horizontal resolution and 350 lines vertical resolution. The television camera was hard mounted into the nose of the aircraft and was steerable $\pm 90^\circ$ in azimuth from dead ahead and 45° in depression from the horizontal (Figure 2). Three interchangeable lenses were used in the video system with the following fields of view:

Wide (16mm): 24.8° vertical x 31.7° horizontal (approx 40° diagonal)

Intermediate (25mm): 15.1° vertical x 20.8° horizontal (approx 26° diagonal)

Narrow (50mm): 7.8° vertical x 10.3° horizontal (approx 13° diagonal)

c. Recording System.

The target search and acquisition imagery was recorded for analysis and as a permanent record, on an International Video Corporation (IVC) 800A video recorder.

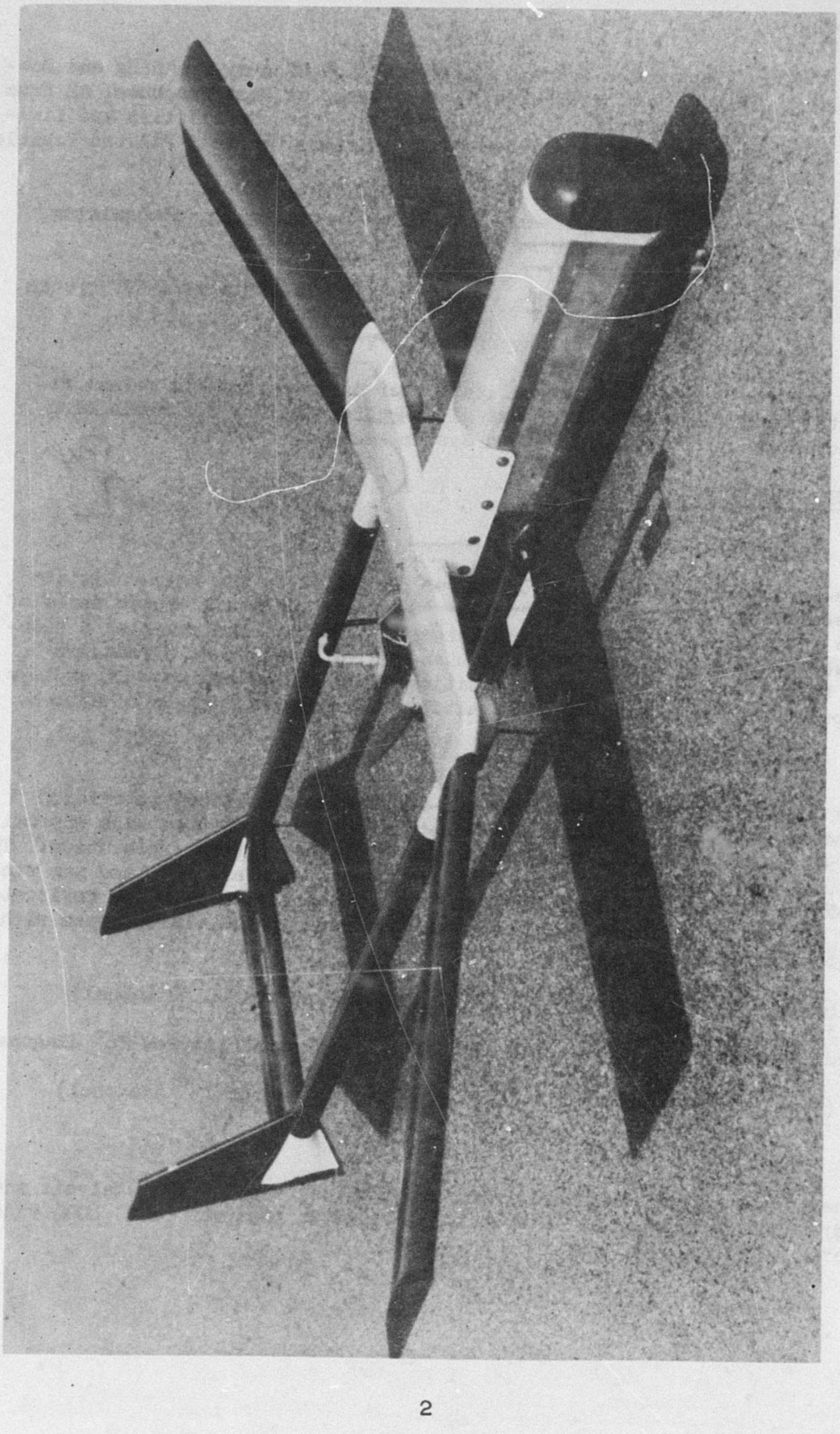

FIG. 1. E-35 MINI-RPV.

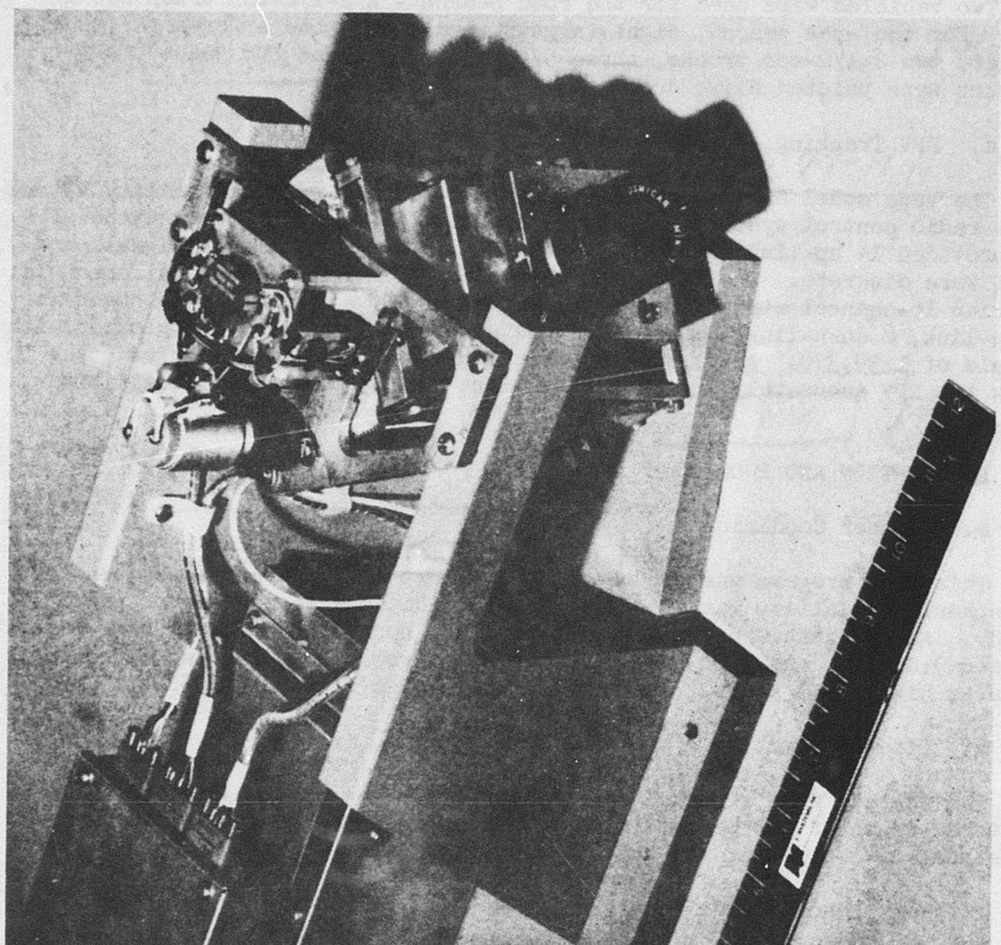

FIG. 2. Miniature TV Camera and Gimbal.

d. Targets.

Two vehicles were used for the road search - a 2-1/2-ton truck and a jeep. For the area search, eight targets were used: one armored personnel carrier, two 2-1/2-ton trucks, three 5/4-ton trucks, and two jeeps. All vehicles were painted olive drab.

e. RPV Tracking, Command and Control.

The Vega model 626C radar was the primary flight control facility with a Kraft radio control system as a manual override. The radar tracked the RPV and provided 14 up-link channels of which six were proportional signals and eight were discrete. The down-link consisted of eight proportional channels. A Varian 16-channel strip chart recorder was used to record the 14 channels (6 up-link, 8 down-link); x-y plots were generated by a Vega x-y plotter with a scale of 1:39,370. An AN/FPS-16 instrumentation tracking radar was used to track the RPV accurately in three dimensions during the target acquisition test.

TEST DESCRIPTION AND PROCEDURE

a. Weather Conditions.

This test program was conducted in a desert environment; consequently, atmospheric visibility was excellent. Sky conditions were clear or partly cloudy. All flights were made during daylight hours and all data were taken between 9:00 A.M. and 5:00 P.M. Winds varied from 5 to 20 knots, with some gusts as high as 40 knots. The temperature ranged from 30° to 70°F.

b. Line-of-Sight.

The targets were situated on flat terrain. The only vegetation was scattered brush of low height. Line-of-sight from the RPV to the target was unobstructed. No effort was made to camouflage the targets.

c. Test Description.

Four target acquisition flight tests were made. Data from three of these flights were analyzed. Data from the fourth flight (in which the wide field-of-view was used) could not be reduced because of a malfunction in the target detection recording equipment. Parameters that were varied included aircraft altitude, and method of target search (road or area). The target acquisition flights are numbered 1, 2, and 3, and are described below.

TABLE 1. FLIGHT TEST NO. 1 (Road Search)

TV Field of View	-	Intermediate
Stationary Targets	-	Jeep, 2-1/2-Ton Truck
Passes/RPV Altitude	-	2/1,000 ft.
		4/1,500 ft.

In this test the aircraft flew over the road at altitudes of approximately 1,000 and 1,500 feet above target level. Targets, one a 2-1/2-ton truck the other a jeep (Figure 3), were deployed approximately 400 feet apart on the road. During this test, six passes were made, two at 1,000 feet and four at 1,500 feet.

TABLE 2. FLIGHT TEST NO. 2 (Road Search)

TV Field of View	-	Narrow
Stationary Targets	-	Jeep, 2-1/2-Ton Truck
Passes/RPV Altitude	-	3/1,000 ft.
		2/1,500 ft.
		2/2,000 ft.
		2/2,500 ft.

The flight paths were identical to flight test No. 1 with flight altitudes at approximately 1,000, 1,500, 2,000, 2,500 feet above target level. There were nine passes, three at 1,000 feet, two at 1,500 feet, two at 2,000 feet and two at 2,500 feet.

TABLE 3. FLIGHT TEST NO. 3 (Area Search)

TV Field of View	-	Intermediate
Stationary Targets (Off Road)	-	2 - Jeeps,
		1 - APC,
		2 - 2-1/2-Ton Trucks,
		3 - 5/4-Ton Trucks
Passes/RPV Altitude	-	18/1,000 ft.

In this test, the aircraft searched a 2km by 2km area by making several predetermined passes designed to provide complete target area coverage. Eight targets, which were described previously, were placed at known positions within the search area (Figure 4). Targets were not placed on roads, nor were the targets' contours broken by adjacent vegetation. The altitude of the aircraft was approximately 1,000 feet above target level with 18 passes being made. The aircraft search geometry is shown in Figure 5.

d. Test Procedure.

All the RPV video was recorded on an IVC video tape recorder. The tape was annotated by an operator to provide information on flight conditions, problems and the beginning and ending of each data pass.

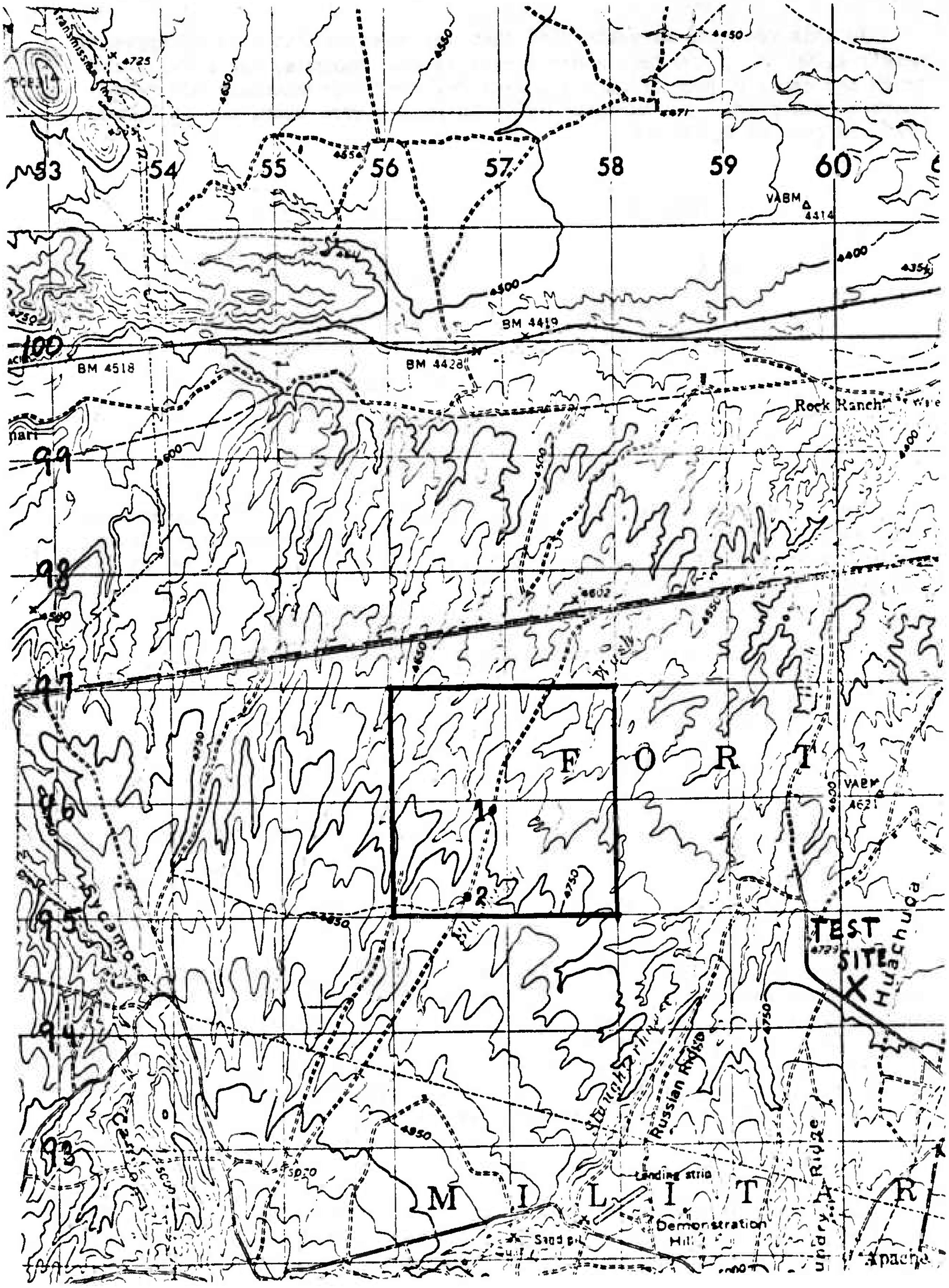

FIG. 3. LOCATION OF TARGETS FOR ROAD SEARCH.

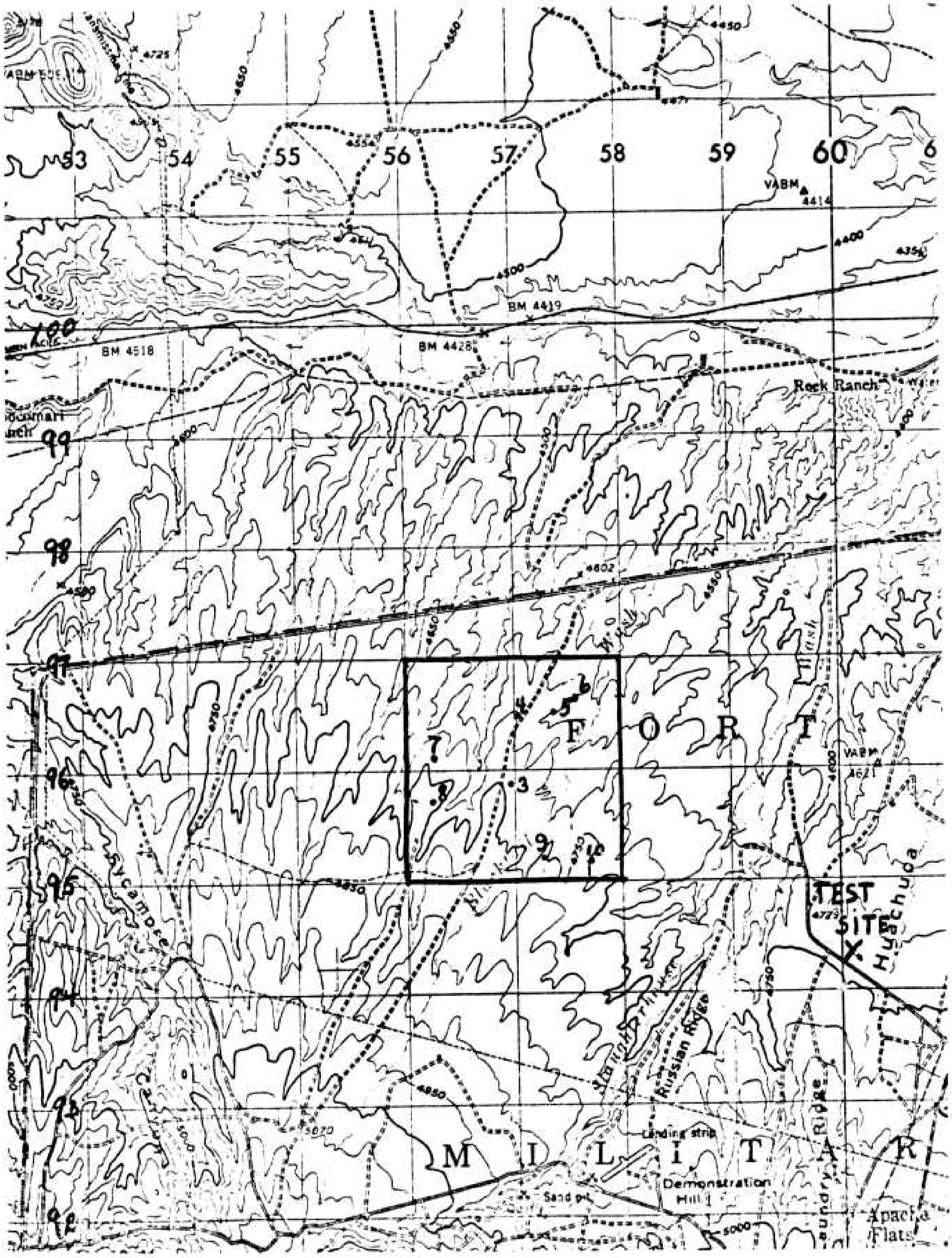

FIG. 4. LOCATION OF TARGETS FOR AREA SEARCH.

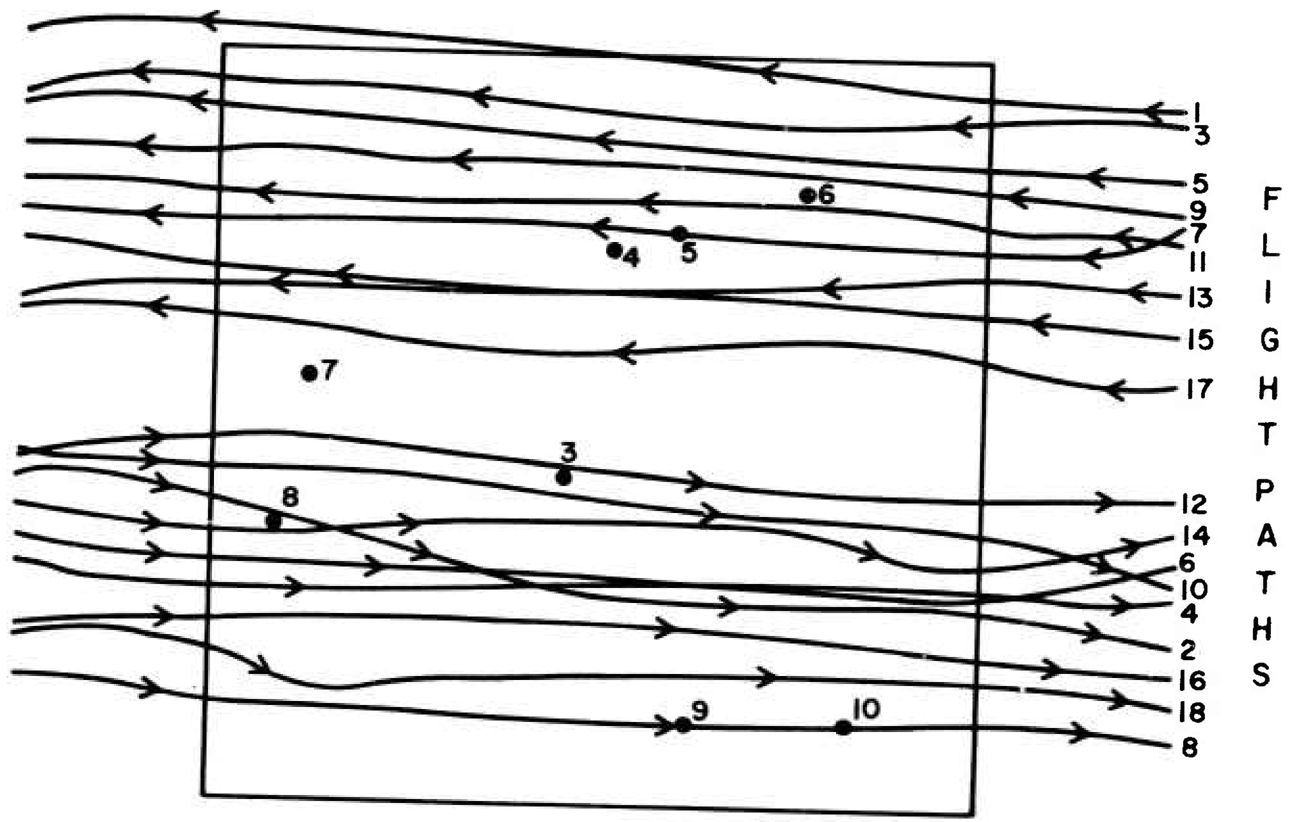

FIG. 5. RPV Passes Over a 2km x 2km Search Area.

Three observers viewed the video during the flight to provide data on target detections. Each observer had two switches beside his video monitor. When he detected a possible target, the first switch was closed for 3-5 seconds. When he recognized the object to be a target, the second switch was closed for 3-5 seconds. Finally when he could identify the target (such as a jeep or 2 1/2-ton truck), both switches were closed for 3-5 seconds.

In addition to the Vega radar, an FPS-16 radar simultaneously beacon-tracked the RPV. The track data were run through a computer which provided a print-out of the RPV position in UTM coordinates in one-second intervals. The observers' detections were recorded on the printout at the time they occurred.

TEST DATA AND DISCUSSION

a. Data Reduction Techniques.

The test data were reduced using the FPS-16 printout of the time history of RPV position and observer inputs, and the sensor video imagery.

The objectives of the data reduction were to determine: (1) Were the target detections, recognitions and identifications made of valid targets? (2) Did target presentations occur which were not observed? (3) What were the RPV-target slant ranges of the valid target detections, recognitions and identifications?

The position of the RPV was plotted for each pass over the target area relative to the known target locations. Using a template representing the size of the TV sensor's footprint on the ground, a determination was made of which targets could have been observed. The video imagery was then reviewed at these points to ascertain whether valid targets were actually visible; if so, this was called a "detection opportunity."

This information was then compared with the FPS-16 printout of the observers' inputs. A determination was then made of the number of detection opportunities, valid target detections, false detections, and missed detections.

The slant range from the RPV to each detected target was then computed from the RPV position at the time of detection.

b. Test Results.

A discussion of the test results follows. A complete listing of target detection, recognition and identification ranges as well as missed and false target detections is provided in the appendix. In the following analysis, if a target was identified or recognized but not detected by an observer, the target was considered to have been detected.

(1) Flight Test No. 1 (Road Search - Intermediate FOV). There were ten occasions when a target appeared in the camera's field-of-view (intermediate) and for all ten opportunities the target was detected by at least one of the observers. The sum of all the detections made by the three observers during

this road search was 23. Of these, 21, or 91.3% , were targets and 2, or 8.7%, were false detections. Table 4 shows a breakdown of target detections by observer and target. Observer 1 detected 9, or 90%, of the 10 target opportunities while observers 2 and 3 detected 6, or 60%, giving an average detection rate of 70% for all three observers.

TABLE 4. SUMMARY OF TARGET DETECTIONS FOR EACH OBSERVER (Road Search - Intermediate FOV)

TARGET TYPE	TARGET OPPORTUNITIES	NO. OF DETECTIONS		
		OBSERVERS		
		NO. 1	NO. 2	NO. 3
Jeep	5	4	3	4
2 1/2-ton Truck	5	5	3	2
TOTALS:	10	9	6	6
PERCENT DETECTED:	100	90	60	60

The maximum slant range at detection was 930 meters. However, this measurement does not represent the limit of the system because target ranges were not increased until detection probabilities fell below 50%,due to time limitations.

Table 5 shows that, of the 21 target detections made by three observers, 5 were either recognitions or identifications. At an altitude of 1,000 feet, one recognition was made at a slant range of 411 meters, and at an altitude of 1,500 feet, a target was recognized at a range of 597 meters. Three targets were identified at ranges of 545, 632,and 393 meters. Therefore, of the 10 separate target appearances 4 targets, or 40% of the target presentations (80% of the trucks, none of the jeeps), were either recognized or identified by at least one observer.

TABLE 5. SUMMARY OF RECOGNITION AND IDENTIFICATION RANGES FOR EACH OBSERVER WITH RESPECT TO TARGET AND ALTITUDE (Road Search - Intermediate FOV)

TARGET TYPE	ALTITUDE (Ft)	RECOGNITION RANGE (Meters)			IDENTIFICATION RANGE (Meters)		
		OBSERVER					
		NO. 1	NO. 2	NO. 3	NO. 1	NO. 2	NO. 3
2 1/2-ton Truck	1,500			597	545		
" " " "	1,500				632		
" " " "	1,000	411					
" " " "	1,000				393		

(2) Flight Test No. 2 (Road Search - Narrow FOV). A target appeared in the camera's field-of-view (narrow) on 16 separate occasions, as shown in Table 6; of these, 14 or 87.5% were detected, while 2 were classified as missed target detections. The total number of detections made by the observers was 29; of these, 25 were target detections, two were non-target detections and two were false detections. As shown in Table 6, which illustrates the distribution of the 25 target detections for each observer, the average target detection rate for all three observers was 52.0 percent. However, observers 1 and 3 detected 75.0% each and observer 2 detected 6.2%. This test, along with the other tests, demonstrates the need for a comprehensive training and screening program for observers.

In this test, the maximum altitude of the aircraft was increased to approximately 2,500 feet, increasing the maximum detection slant range to 1,514 meters. Although the altitude was 1,000 feet higher than that in Flight Test No. 1, the maximum detection slant range does not represent the limit of the system. During this test, difficulty was encountered in keeping the target road in the sensor's field-of-view. This problem occurred during moderately windy conditions, indicating the need for stabilized sensors for narrow field-of-view operation.

TABLE 6. SUMMARY OF TARGET DETECTIONS FOR EACH OBSERVER
(Road Search - Narrow FOV)

TARGET TYPE	TARGET OPPORTUNITIES	NO. OF DETECTIONS		
			OBSERVER	
		NO. 1	NO. 2	NO. 3
Jeep	7	4	0	4
2-1/2-ton Truck	9	8	1	8
TOTALS:	16	12	1	12
PERCENT DETECTED:	87.5	75.0	6.2	75.0

Table 7 shows that of the 25 target detections made by the three observers, 18 were either target recognitions or target identifications. The maximum target recognition slant range was 1,117 meters from an altitude of 2,500 feet. The maximum target identification slant range was 716 meters. Of the 16 targets that were presented, 10 or 62.5%, were either recognized and/or identified using the narrow field-of-view lens.

TABLE 7. SUMMARY OF RECOGNITION AND IDENTIFICATION RANGES FOR EACH OBSERVER WITH RESPECT TO TARGET AND ALTITUDE
(Road Search - Narrow FOV)

TARGET TYPE	ALTITUDE (Ft)	RECOGNITION RANGE (Meters)			IDENTIFICATION RANGE (Meters)		
		OBSERVER			OBSERVER		
		NO. 1	NO. 2	NO. 3	NO. 1	NO. 2	NO. 3
2-1/2-ton Truck	2,500	1,117					
2-1/2-ton Truck	2,000	864		892			
2-1/2-ton Truck	1,500	654	786	851	613		
Jeep	1,500	828					
2-1/2-ton Truck	1,500			645			
2-1/2-ton Truck	1,500	455		774	716		
Jeep	1,000	416					
Jeep	1,000	485					
2-1/2-ton Truck	1,000	431					
2-1/2-ton Truck	1,000	719		756			662

(3) **Flight Test No. 3 (Area Search - Intermediate FOV).** Eighteen passes were made during this area search test. Table 5 lists each target that appeared in the camera's FOV during each pass and which observer detected these targets. A total of 13 targets appeared and 11, or 84.6 percent, were detected by at least one of the observers. The detection breakdown by observer is: Observer 1 - 76.9 percent; Observer 2 - 61.5 percent; and Observer 3 - 15.4 percent. Again, there is a disparity in the ability of the observers to make a target detection.

TABLE 8. TARGET DETECTIONS MADE PER PASS FOR EACH OBSERVER
(2km x 2km Area Search - Intermediate FOV)

PASS	TARGET	DETECTION	OBSERVERS NO. 1	NO. 2	NO. 3
1	No target opportunity				
2	(8) 2-1/2- ton	x	x	x	
3	No target opportunity				
4	No target opportunity				
5	No target opportunity				
6	No target opportunity				
7	(5) 5/4 ton				
7	(4) 2-1/2-ton	x	x	x	x
8	(10) Jeep				
8	(9) 5/4-ton	x	x	x	
9	(6) Jeep	x	x	x	
10	(3) APC	x	x	x	
11	(6) Jeep	x	x	x	
11	(5) 5/4-ton	x	x		
11	(4) 2-1/2-ton	x	x	x	
12	(3) APC	x			x
13	No target opportunity				
14	(8) 2-1/2-ton	x	x	x	
15	No target opportunity				
16	No target opportunity				
17	(7) 5/4-ton	x	x		
18	No target opportunity				
TOTALS:	13 (Target Opportunities)	11	10	8	2
PERCENT:	100	84.6	76.9	61.5	15.4

An analysis of area search for targets in clutter was developed by Bailey.[1] For readily detectable targets (i.e., good contrast, sufficient resolution), the probability of target detection as a function of area search rate is given by:

$$P_d = 1 - e^{-\frac{700\,a_t}{G\dot{A}}}$$

where: a_t = target presented area (m^2)
$\dot{A}$ = area search rate (m^2/sec)
G = scene congestion factor (possible targets per 100 x a_t)

1. H. H. Bailey, "Target Detection Through Visual Recognition: A Quantitive Model," The Rand Corporation Memo RM-6158-PR, Feb 1970.

For the area search test, the search rate based on the average scene width was 5,000 m^2 per second. For the 8 targets employed, the average presented area was 14.5 m^2 when viewed at 45° from the vertical.

The average congestion factor determined by examination of ten sample frames from the search areas was 1.1.

For the above parameters, the probability of detection is computed to be 84.1 percent.

The average for all three observers was 51.2%; however, Observer 3 differed so markedly from the other two in detection probability that a consideration of the probability of detection of Observers 1 and 2 might be more representative. This average was 69.2 percent. Considering the variables involved, this average compares favorably with the theoretical 84.1% detection probability.

An additional factor that would lower the detection probabilities is the effect of image motion (i.e., RPV motion). The effect of linear scene motion on ground resolution is presented by Rosell[2] in his paper "Performance Synthesis of Electro-Optical Sensors." With an RPV speed of 60 knots (30 m/sec) the apparent image motion for a sight-line depression angle of 45° is 21.2m per second which corresponds to a maximum ground resolution of .70 meter.

Two of the eight area targets were jeeps with a minimum target dimension of 1.55 meters. This means that the maximum number of TV lines across the jeep's minimum dimension was 2. Johnson,[3] in his paper "Analysis of Image Forming Systems," has determined that this resolution corresponds to a detection probability of 50 percent. This reduction in detection probability averaged over eight targets would be 12.5 percent. This would then lower the theoretical detection probability to 71.6% which agrees well with the average for Observers 1 and 2.

Table 9 lists the total detections of all three observers for each pass. The total detections were composed of:

(1) actual target detections

(2) non-target vehicle detections

(3) false detections.

---

2. F.A. Rosell and R.H. Willson, "Performance Synthesis of Electro-Optical Sensors," Westinghouse Defense and Electronic Systems Technical Report AFAL-TR-73-260, Aug 1973.
3. John Johnson, "Analysis of Image Forming Systems," (Proceedings) Image Intensifier Symposium, US Army Engineers R&D Laboratory, Ft Belvoir, VA., p 249-273, 6-7 Oct 1958.

The three observers made a total of 36 detections of which 20 were true target detections, 8 were non-target detections, and 8 were false detections. If we group target detections and non-target detections then 28 of the 36 detections (77.8%) were target detections and 8 of the 36 (22.2%) were false detections.

TABLE 9. TOTAL DETECTION OF ALL THREE OBSERVERS FOR EACH PASS (2km x 2km Area Search - Intermediate FOV)

PASS	TOTAL DETECTIONS	TARGET DETECTIONS	NON-TARGET VEHICLE DETECTIONS	FALSE DETECTIONS
1	0	0	0	0
2	7	2	3	2
3	0	0	0	0
4	3	0	2	1
5	0	0	0	0
6	2	0	2	0
7	4	3	0	1
8	2	2	0	0
9	3	2	0	1
10	2	2	0	0
11	5	5	0	0
12	1	1	0	0
13	1	0	0	1
14	2	2	0	0
15	2	0	0	2
16	1	0	1	0
17	1	1	0	0
18	0	0	0	0
TOTALS:	36	20	8	8
PERCENT:	100	55.6	22.2	22.2

The time required to search the four square kilometer target areas was 93 minutes or 23 min/km^2. This extended search time is unfavorable when viewed from the RPV survivability aspect and the responsiveness of the system in detecting targets. Efforts to reduce the search time are limited by the two effects studied by Bailey and Rosell.

Increasing the area search rate will rapidly reduce the probability of target detection due to sensor operator overload. If the increased search rate is achieved by increasing the RPV speed, ground resolution deteriorates resulting in poor detection probabilities for smaller targets (jeeps, 1-1/4-ton trucks). This effect could be reduced by increasing TV frame rate or increasing the number of resolution elements per TV line, both of which would increase the video data link band width requirements. All of the above leads one to the conclusion that frame-type TV cameras are not well suited to providing large area target search capability in the absence of a target cueing device.

CONCLUSIONS

a. Road Search - Detection.

The detection of tactical targets on roads or other narrow arteries of travel with a RPV-borne unstabilized TV sensor is feasible. Individual observer detection probabilities varied from 6% to 90% at ranges up to 1,500 meters. This variability in observer performance indicates the need for a comprehensive training and screening program for observers.

Difficulty was encountered during moderate gust conditions in keeping the road being searched in the TV sensor's field-of-view, which brings into question the practicality of employing unstabilized sensors for road search. This pointing problem indicates that maximum target detection ranges would be severely limited without sight-line stabilization, since the reduced fields-of-view required would only aggravate the problem.

An additional limitation is introduced by image smear caused by the RPVs forward motion. For the conditions of this test (RPV Speed - 60 knots and sightline depression angle - 45°), the ability to detect a small tactical target, such as a jeep, is marginal. For higher RPV speed, the RPV-target sightline must be positioned more obliquely to reduce target image smear.

b. Road Search - Recognition and Identification.

Only 40% of the targets presented were either recognized or identified by any of the observers using the intermediate field-of-view (26° diagonal). This proportion increased to 62.5% for the narrow field-of-view (13° diagonal). The maximum recognition range was 1.1km. Increased recognition and identification performance would most likely be achieved in practice since the observer would then have control of the sensor operation and could dwell on a detected target until an identification was made.

c. Area Search.

Area search for tactical targets is not considered to be practical using airborne TV-frame cameras. The time required to search was 23 min/km^2. RPV survivability and target mobility considerations would probably limit area search operations to a fraction of a square kilometer.

Efforts to increase the target search rate are limited by factors such as operator workload, image smear, and sensor bandwidth (for frame TV's).

During the area search 13 targets appeared, of which 11 were detected by at least one of the observers. The experimental results agree well with analytical prediction, based on the effects of target clutter and image smear on detection probability.

APPENDIX — COMPLETE LISTING OF OBSERVATIONS FOR FLIGHT TEST NO. 1

TABLE 10. SUMMARY OF VALID DETECTION, RECOGNITION AND IDENTIFICATION RANGES, MISSED DETECTIONS, AND FALSE DETECTIONS (FLIGHT TEST NO. 1)

PASS NO.	TARGET TYPE	ALTITUDE (FT)	DETECTION RANGE (METERS) OBSERVER			RECOGNITION RANGE (METERS) OBSERVER			IDENTIFICATION RANGE (METERS) OBSERVER		
			1	2	3	1	2	3	1	2	3
1	(2) Jeep	1500	518.5								
1	(1) 2-1/2 ton	1500	777.7		777.7						
2	FD	1500	X	X							
3	(2) Jeep	1500	694.6	694.6	629.4						
3	(1) 2-1/2 ton	1500	930.0	908.9	706.3			597	544.5		
4	(1) 2-1/2 ton	1500	828.0						631.9		
4	(2) Jeep	1500			615						
5	(2) Jeep	1000	506	488	416						
5	(1) 2-1/2 ton	1000	540.2	540.2		410.5					
6	(1) 2-1/2 ton	1000	D	541.9					393.3		
6	(2) Jeep	1000	448	448	384						

D - Observer indicates detection by either recognition or identification
FD - False Detection

TABLE 11. SUMMARY OF VALID DETECTION, RECOGNITION AND DETECTION RANGES, MISSED DETECTIONS AND FALSE DETECTIONS (FLIGHT TEST NO. 2)

PASS NO	TARGET TYPE	ALTITUDE (FT)	DETECTION RANGE (METERS) OBSERVER 1	2	3	RECOGNITION RANGE (METERS) OBSERVER 1	2	3	IDENTIFICATION RANGE (METERS) OBSERVER 1	2	3
1	(2) 2-1/2-ton	2500			1514						
2	MD (1) Jeep	2500									
2	(2) 2-1/2-ton	2500	1181		1208	1117					
2	FD	2500	X								
3	FD	2000			X						
3	(2) 2-1/2-ton	2000	816		831						
3	NT	2000	X								
4	MD (1) Jeep	2000									
4	(2) 2-1/2-ton	2000	976		1007	864		892			
4	NT	2000	X								
5	(2) 2-1/2-ton	1500	930	D	D	654	786	851	613		
5	(1) Jeep	1500	D		661	828					
6	(1) Jeep	1500			689						
6	(2) 2-1/2-ton	1500	745		713			645			
7	(2) 2-1/2-ton	1000	794		D	455		774	716		
7	(1) Jeep	1000	474		446	416					
8	(1) Jeep	1000	D			485					
8	(2) 2-1/2-ton	1000	D			431					
9	(2) 2-1/2-ton	1000	952		952	719		756			662
9	(1) Jeep	1000	436		468						

NT - Non-Target
FD - False Detection
MD - Missed Detection
D - Observer indicates detection by either recognition or identification

TABLE 12. SUMMARY OF VALID DETECTION, RECOGNITION AND DETECTION RANGES, MISSED DETECTIONS AND FALSE DETECTIONS (FLIGHT TEST NO. 3)

PASS NO.	TARGET TYPE	ALTITUDE (FT)	DETECTION RANGE (METERS) OBSERVER 1	2	3	RECOGNITION RANGE (METERS) OBSERVER 1	2	3	IDENTIFICATION RANGE (METERS) OBSERVER 1	2	3
2	(8) 2-1/2-ton	1000	595	496.6							
2	NT	1000	X	X	X						
2	FD	1000		X	X						
4	FD	1000		X							
4	NT	1000	X	X							
6	NT	1000	X	X							
7	FD	1000	X								
7	MD (5) 5/4-ton	1000									
7	(4) 2-1/2-ton	1000	412	531.8	531.8				341.8		
8	(9) 5/4-ton	1000	529.3	529.3			450.7				
8	MD (10) Jeep	1000									
9	(6) Jeep	1000	458.3	D			441.9				
9	FD				X						
10	(3) APC	1000	553.0	553.0			443.4				
11	(6) Jeep	1000	577.5	D			455.7				
11	(5) 5/4-ton	1000	511.6						412.4		
11	(4) 2-1/2-ton	1000	460.3						401.7		
12	(3) APC	1000			525.1						
13	FD	1000			X						
14	(8) 2-1/2-ton	1000	D	530.9					412.0		
15	FD	1000	X		X						
16	NT	1000	X								
17	(7) 5/4-ton	1000	514.1								

NT- Non Target
FD- False Detection
MD- Missed Detection